Camp Lick

Fire, Fuels, and Air Quality Report

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for:

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Introduction

The Camp Lick Project on the Malheur National Forest is proposing to move forest stands toward resilient conditions. The purpose and need for the project include:

- Protect firefighter safety and improve readiness to manage wildfires through safe public access improvements.
- Protect resource values and private land.
- Reduce fuel loading and continuity by reducing the density and horizontal and vertical connectivity of standing vegetation, surface fuels, and/or ladder fuels.
- Reduce fuels along Forest Service Road (FSR) 36, which is identified as an escape corridor in the Grant County Community Fire Protection Plan, and FSR 3640, 3660, 3670, and 3675, which are identified as priority Forest Service corridors .

The planning area covers approximately 40,000 acres on National Forest System lands. Fire is the most widespread and dynamic disturbance regime affecting the planning area. The area is characterized by terrain that influences the structure, composition, and productivity of vegetation. These vegetation patterns in turn influence fire behavior and patterns of fire severity. A combination of treatments would be used across the planning area, resulting in some acres being treated with multiple prescriptions to achieve stated objectives.

Regulatory Framework for Fire and Fuels

The proposed action for the Camp Lick Project was developed to comply with applicable management direction as well as all Federal, State, and local laws, regulations, and policies. Direction for the proposed action is derived from the following:

Malheur National Forest Land and Resource Management Plan (1990)

Desired Future Condition

"Prescribed fire will have played a role in converting 75,000 acres of mixed conifer stands back to ponderosa pine stands. Most all of the subclimax ponderosa pine timber type will have been underburned. Ground fuels will be reduced significantly, resulting in increased range and wildlife forage. Total smoke production on an annual basis will be reduced substantially as a result of fewer and lower intensity wildfires.

The use of prescribed fire as a management tool will be extensive. Underburning (the use of low intensity ground fire), will be common for managing mixed ponderosa pine and associated fir stands to reduce fir encroachment and perpetuate ponderosa pine. By the end of this period, 1,000 acres will be burned as rangeland improvement and another 2,000 to 4,000 acres as wildlife habitat improvement. Smoke from these projects will be visible during spring, early summer, and fall" (USDA Forest Service 1990, page IV-10).

Forestwide Standards

Forest-wide standard #57: Maintain or enhance quaking aspen stands using clearcutting and prescribed fire as the principal means of regeneration where appropriate. Protect root sprouts where needed and practical (USDA Forest Service 1990, page IV-31).

Forest-wide standard #180: Utilize prescribed fire to meet land management objectives. Normally, plan human ignition sources for prescribed fire; however, when appropriate, utilize lightning ignition sources for prescribed fire (USDA Forest Service 1990, page IV-45).

Forest-wide standard #181: Manage residue profiles at a level that will minimize the potential of high intensity catastrophic wildfires and provide for other resource objectives in individual management areas (USDA Forest Service 1990, page IV-45).

Forest-wide standard #183: Use all methods of fuel treatment as prescribed by site-specific analysis to achieve resource management objectives. Encourage utilization of wood residue as a priority treatment, consistent with long-term site productivity and wildlife habitat needs (USDA Forest Service 1990, page IV-129).

Forest-wide standard #184: Integrate residue treatment with pest management practices (USDA Forest Service 1990, page IV-45).

General Forest Management Area 1

See Forest-wide standards.

Rangeland Management Area 2

MA2 standard #6: When appropriate, utilize prescribed fire from planned ignitions (USDA Forest Service 1990, page IV-53).

Riparian Areas (Management Areas 3A and 3B) / Riparian Habitat Conservation Areas

MA3A standard #48 and MA3B standard #49: Manage residue profiles to maintain or enhance resident fish and wildlife habitat (USDA Forest Service 1990, pages IV-60 and IV-68).

MA3A standard #49 and MA3B standard #50: A site specific analysis is required for determining removal of activity-generated woody debris from all riparian areas unless nonremoval is specifically evaluated and approved in the project-level environmental analysis. Do not allow mechanized treatment of logging debris for site preparation or hazard reduction purposes in all riparian areas, unless evaluated and approved in a project-level environmental analysis. Burning of logging debris below the high waterline is prohibited (USDA Forest Service 1990, pages IV-61 and IV-68).

MA3A standard #50 and MA3B standard #51: Use prescribed fire from planned ignitions to achieve forage production objectives (USDA Forest Service 1990, pages IV-61 and IV-68).

Big Game Winter Range Maintenance Management Area 4A

MA4A standard #27: Manage residue profiles to maintain or enhance big-game habitat and forage production (USDA Forest Service 1990, page IV-72).

MA4A standard #28: Limit treatment activities between Dec. 1 and April 1 to reduce disturbances to wintering elk and deer (USDA Forest Service 1990, page IV-72).

Developed Recreation Sites Management Area 12

MA12 standard #22: Prescribe low intensity fire with minimal scorch when appropriate (USDA Forest Service 1990, page IV-103).

Old Growth Management Area 13

MA13 standard #20: Manage residue to maintain or enhance old-growth habitat. Protect old-growth habitat from catastrophic wildfire (USDA Forest Service 1990, page IV-107).

Visual Corridors Management Area 14

MA14 standard #27: Manage residues to provide a natural-appearing landscape in visual corridors (USDA Forest Service 1990, page IV-111).

MA14 standard #28: Plan and time treatments in foreground distance zones to minimize adverse visual effects (USDA Forest Service 1990, page IV-111).

MA14 standard #29: Prescribe low intensity fire with minimal scorch when appropriate (USDA Forest Service 1990, page IV-111).

Malheur National Forest Fire Management Plan (2013)

Federal Wildland Fire Management Policy and Program Review (USDA and USDI 1995) and the Wildland and Prescribed Fire Management Policy and Implementation Procedures Reference Guide (Forest Service Manual 5101, 5103, and 5108); require development of a Fire Management Plan (FMP) for all federal lands subject to wildland fires. It is implemented on the authorities of Forest Service Manual (FSM) direction contained in FSM 5101 and 5108.

The National Forest Management Act (NFMA) of 1976, including its amendments to the Forest and Rangeland Renewable Resources Planning Act of 1974, state that it is the policy of the Congress that all forested lands in the National Forest System be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth, and conditions of stand designed to secure the maximum benefits of multiple use sustained yield management in accordance with land management plans.

The National Fire Plan (NFP), Managing the Impacts of Wildfires on Communities and the Environment (USDA and USDI. 2000), provides national direction for hazardous fuel reduction, restoration, rehabilitation, monitoring, applied research, and technology transfer. The agencies are developing a common strategy for reducing fuels and restoring land health in fire-prone areas. The Forest Service prepared a document outlining strategies for protecting people and the environment by restoring and sustaining land health: Protecting People and Sustaining Resources in Fire-adapted Ecosystems. The NFP is focused on firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability. The guiding principle for dealing with fire risks is the reduction of hazardous fuel loads threatening communities and wildland ecosystems.

Protecting People and Sustaining Resources in Fire-Adapted Ecosystems, a Cohesive Strategy, October, 2000: The 10-Year Comprehensive Strategy (USDA Forest Service 2000) reflects the views of a broad cross-section of governmental and non-government stakeholders. It outlines a comprehensive approach to the management of wildland fire, hazardous fuels, and ecosystem restoration and rehabilitation on Federal, adjacent State, tribal, private forest and range lands. The hazardous fuel reduction portion of this strategy calls to; “Assign highest priority for hazardous fuels reduction to communities at risk, readily accessible municipal watersheds, threatened and endangered species habitat, and other important local features, where conditions favor uncharacteristically intense fires.”

Grant County, Oregon Community Wildfire Protection Plan (2005)

The purpose of the Community Wildfire Protection Plan (CWPP) is for communities to take full responsibility and advantage of wildland fire and hazardous fuel management opportunities offered under Healthy Forest Restoration Act (HFRA) legislation. The CWPP provides for the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), and other federal agencies to give consideration to the priorities of local communities for forest and rangeland management as well as hazardous fuel reduction projects.

Prescribed fire in Grant County could be used to accomplish a number of resource management purposes, such as reducing the amount of hazardous fuels, improving plant species diversity, increasing livestock forage production, abating noxious and invasive weeds, and improving wildlife habitat. Multiple resource management objectives are often achieved concurrently.

Regulatory Framework for Air Quality

The framework for controlling air pollutants is mandated by the 1970 Clean Air Act (CAA), as amended. The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

The CAA was designed to “protect and enhance” the quality of air resources, and encourage reasonable actions for pollution prevention. State Implementation Plans are developed to implement provisions of the CAA, specifically the National Ambient Air Quality Standards. Section 160 of the CAA requires measures “to preserve, protect, and enhance the air quality in national parks, national wilderness areas … and other areas of special national or regional natural, recreational, scenic, or historic value” (42 USC 2013). Stringent requirements are established for areas designated as Class 1 airsheds, which include wilderness areas over 5,000 acres in existence before August 1977. Designation as a Class I area allows only very small increments of new pollution above existing levels.

The Regional Haze Rule (40 CFR 51.308-309) requires states to establish goals for improving visibility in Class 1 airsheds and to develop long-term strategies for reducing emissions of air pollutants that cause visibility impairment. The Regional Haze Rule requires smoke management programs to address visibility impairment in mandatory Class 1 airsheds due to emissions from prescribed fire activities. The State has designated all Class 1 airsheds sensitive to smoke during the visibility protection period, which is defined as July 1 to September 15, during which restrictions on burning apply for purposes of visibility protection.

Prescribed burning in Oregon is managed by the Oregon Department of Forestry under the Oregon Smoke Management Plan (OAR 629-048). The Oregon Smoke Management Plan is intended to minimize smoke impacts by conducting forest burning under weather conditions that disperse smoke and direct smoke away from populated areas. Burning on National Forest System lands only occurs with prior approval granted by the Oregon Department of Forestry.

Resource Elements, Indicators and Measures

The resource indicators used in this report are:

- Flame length: The length of flame measured in feet. Increased flame lengths reduces fire suppression strategies and effectiveness and increases the likelihood of torching events and crown fires.
- Fireline intensity: The product of the available heat of combustion per unit of ground and the rate of spread of the fire, interpreted as the heat released per unit of time for each unit length of fire edge. The primary unit is British thermal unit per second per foot (Btu/sec/ft) of fire front. A British thermal unit (Btu) is the amount of work needed to raise the temperature of one pound of water by one degree Fahrenheit.
- Crown fire activity: Fire that burns in the crowns of trees and shrubs. Usually ignited by a surface fire. Crown fires are common in coniferous forests and chaparral-type shrublands. There are two types of crown fire: active and passive. An active crown fire is one in which the entire fuel strata is involved in flame, but the crowning phase remains dependent on heat released from surface fuel for continued spread. A passive crown fire is one in which the crowns of individual trees or small groups of trees burn, but solid flaming in the canopy cannot be maintained except for short periods.
- Smoke emissions: Over 90 percent of emissions from fires are small enough to enter the respiratory system. Inhaling carbon monoxide decreases the body's oxygen supply. Fine particles in the air are able to travel deep into the respiratory tract and cause shortness of breath or worsen pre-existing medical conditions such as asthma. Exposure can depress the immune system and damage the layer of cells in the lungs that protect and cleanse the airways. Smoke emissions also contain greenhouse gasses which are a contributor to climate change. Specific compounds most commonly found in smoke emissions that contribute to health concerns and climate change are particulate matter ($PM_{2.5}$ and PM_{10}), methane (CH4), carbon dioxide (CO_2), carbon monoxide (CO), nitrous oxide (N_2O), ozone (O_3), and sulfur oxide (SO_2).

These are appropriate indicators for this analysis because they give information about potential fire behavior, fire effects, and smoke emissions. Risks to firefighters, workers, and the public can be assessed from potential fire behavior and smoke emissions. The fuel load not only determines whether or not a fire will grow, but together with the type of fuel they determine the fire intensity and effects. Flame length and fireline intensity influence suppression strategies and tactics by firefighters and mechanical equipment. Smoke emissions contribute to climate change.

Table 1. Measures and indicators for assessing resource effects

Resource element	Resource indicator	Measure (quantify if possible)	Source
Flame length	Length of flame (feet)	Feet	Andrews and Rothermel (1982)
Fireline intensity	Rate of heat release per unit of length of fire front	British thermal unit (Btu)/foot/second	Andrews and Rothermel (1982)
Crown fire activity	Surface, passive, active	Activity type	Andrews and Rothermel (1982)
Smoke emission	$PM_{2.5}$, PM_{10}, CH_4, CO, CO_2, NO_2, O_3, SO_2	Tons released	EPA Greenbook (2016)

Fire, Fuels, and Air Quality

Affected Environment

Methodology

Field inventories were conducted to measure attributes of existing vegetation in the planning area. Treatments units within the planning area were inventoried using on-site photo interpretation and forest vegetation simulator (FVS). These treatment units are representative of the planning area and the project areas to be treated in alternative 2. Data was collected on live and dead trees. These data were used in the following analysis, data tables, graphs, and charts and are incorporated by reference. GIS Land Fire Data and onsite visits were used to determine fuel models, as was a study conducted in 2005 (Scott and Burgan 2005). *A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model* was used for fire modeling. Analysis for fire behavior was calculated using the 90th percentile fire weather factors from Keeney Two Weather Station during 1995-2016 (5,120 feet elevation; May 1-Oct 31). Table 4 displays Keeney Two's data. The Forest uses 90th percentile[1] weather to define the extreme conditions for an area using historical weather data of that area.

The dynamics between vegetation and fire and fuels are inherently linked. Fire has a profound effect on vegetation establishment and development, and vegetation treatments (and the absence thereof) have a profound effect on fuels accumulations and fire behavior. The analysis considers forest vegetation, fuels, and fire at the stand level.

The effects of treatments (or lack thereof) on fire behavior, fire effects, and fire suppression capability were analyzed for each alternative. The analysis of fire effects used flame length, fireline intensity, and crown fire activity. Flame lengths and fireline intensities were based on fuel models. Dead and live fuels used in fuel models are described by size. For example, 1-hour fuels are typically fine, flashy fuels smaller than 0.25 inches in diameter, 10-hour fuels are 0.25 to 1 inch in diameter, 100-hour fuels are 1 to 3 inches in diameter, and 1000-hour fuels are often termed coarse woody debris and are greater than 3 inches in diameter. Fuel models are described by the volume of 1-hour, 10-hour, 100-hour, and 1000-hour dead fuels; herbaceous and woody live fuels; fuel bed depth; and moisture of extinction. Coarse woody debris (CWD) is 1,000 hour dead fuel, with a minimum diameter (or an equivalent cross section) of 3 inches at the widest point and includes sound and rotting logs, standing snags, stumps, and large branches (located above the soil) (Enrong et al. 2006). Crown fire activity level is based on fuel models, canopy base heights, and canopy bulk density. Fuel models are used to determine the flame length. Flame length and the distance to the canopy base height determines crown fire initiation. The density of the canopy determines the type of crown fire the stand may have under a certain weather percentile. Fuel conditions resulting from implementation of each of the alternatives would have associated effects on fire behavior.

Fire effects are estimated as the predicted flame length (feet), the predicted fireline intensity (Btu) per foot per second) at the flaming front, and the crown fire activity (surface, passive, or active).

[1] Percentiles are used to help measure the significance of outputs as they relate to levels of fire risk, fuel conditions, and fire danger. Weather percentiles are based on a scale of 0-100, and utilize weather data compiled by the National Digital Forecast Database to average weather conditions for the area. The top 90th percentile weather means that only 10 percent of days have had weather values the same or higher. These conditions warrant the classification of "extreme" for fire hazard, and might be characterized by high temperatures, low humidity levels, high winds, and/or other conditions that drive fire behavior.

Increased flame lengths can increase the likelihood of torching events and crown fires. Flame length is influenced in part by fuel type, fuel arrangement, fuel moisture, and weather conditions. Flame length and fireline intensity influence production rates, or how fast firelines can be constructed by different suppression resources, including hand crews and mechanical equipment. Flame lengths over 4 feet, or fireline intensities over 100 Btu per foot per second, may present serious control problems. These conditions are too dangerous to be directly contained by hand crews (Schlobohm and Brain 2002; Andrews and Rothermel 1982). Flame lengths over 8 feet or fireline intensities over 500 Btu per foot per second are generally not controllable by ground-based equipment or aerial retardant, and present serious control problems including torching, crowning, and spotting. Flame length and fireline intensity directly affects suppression tactics. Table 2 outlines how flame lengths and fireline intensities influence fire suppression actions (Andrews et al. 2011).

Table 2. Predicted average surface fire flame length, fireline intensity, and suppression actions

Flame length (feet)	Fireline intensity (Btu/foot/second)	Suppression actions
<4	<100	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4 – 8	100 – 500	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 – 11	500 – 1,000	Fires may present serious control problems—torching, crowning, and spotting is common. Control efforts at the fire head will probably be ineffective
>11	>1,000	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Predicting the potential behavior and effects of wildland fire is an essential task in fire management. Mathematical surface fire behavior and fire effects models and prediction systems are driven in part by fuelbed inputs such as load, bulk density, fuel particle size, heat content, and moisture of extinction. To facilitate use in models and systems, fuelbed inputs have been formulated into fuel models (Scott and Burgan 2005). Table 3 displays a list of fuel models that are or can be expected to be in the planning area over the next 20 years. The average flame length and fireline intensity numbers are based on 90th percentile weather conditions (Table 4).

Table 3. Fuel models and fire behavior under 90th percentile weather conditions

Fuel model	Short description	Long description	Predicted flame length (feet)	Fireline intensity (Btu/foot/second)
NB	No fuel base	There is no fuel load—wildland fire will not spread. Examples of fuel model NB include open water, urban development, or bare ground.	0	0
GR1	Short, sparse dry climate grass	The primary carrier of fire in GR1 is sparse grass, though small amounts of fine dead fuel may be present. The grass in GR1 is generally short, either naturally or by grazing, and may be sparse or discontinuous.	2	15

Fuel model	Short description	Long description	Predicted flame length (feet)	Fireline intensity (Btu/foot/ second)
GR2	Short grass moderate load	The primary carrier of fire in GR2 is grass, though small amounts of fine dead fuel may be present. Load is greater than GR1, and fuelbed may be more continuous. Shrubs, if present, do not affect fire behavior.	4	150
GR3	Low load, very coarse, humid climate grass	The primary carrier of fire in GR3 is continuous, coarse, humid-climate grass. Grass and herb fuel load is relatively light; fuelbed depth is about 2 feet. Shrubs are not present in significant quantity to affect fire behavior.	7	450
GS1	Low load, dry climate grass-shrub	The primary carrier of fire in GS1 is grass and shrubs combined. Shrubs are about 1 foot high, grass load is low. Spread rate is moderate; flame length low. Moisture of extinction is low.	3	100
GS2	Grass and shrub	The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate.	5	200
SH2	Moderate load dry climate shrub	The primary carrier of fire in SH2 is woody shrubs and shrub litter. Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate is low; flame length low.	5	200
TU1	Low load dry climate timber-grass-shrub	The primary carrier of fire in TU1 is low load of grass and/or shrub with litter. Spread rate is low; flame length low.	2	25
TU2	Moderate load, humid climate timber-shrub	The primary carrier of fire in TU2 is moderate litter load with shrub component. High extinction moisture. Spread rate is moderate; flame length low.	4	100
TU3	Moderate load, humid climate timber-grass-shrub	The primary carrier of fire in TU3 is moderate forest litter with grass and shrub components. Extinction moisture is high. Spread rate is high; flame length moderate.	8	500
TU5	Very high load, dry climate timber-shrub	The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length moderate	8	500
TL3	Moderate load conifer litter	The primary carrier of fire in TL3 is moderate load conifer litter, light load of coarse fuels. Spread rate is very low; flame length low.	1	4
TL4	Small down log	The primary carrier of fire in TL4 is moderate load of fine litter and coarse fuels. Includes small diameter downed logs. Spread rate is low; flame length low.	1	5

Fuel model	Short description	Long description	Predicted flame length (feet)	Fireline intensity (Btu/foot/ second)
TL5	High load conifer litter	The primary carrier of fire in TL5 is high load conifer litter; light slash or mortality fuel. Spread rate is low; flame length low.	2	10
TL6	Moderate load broadleaf litter	The primary carrier of fire in TL6 is moderate load broadleaf litter. Spread rate is moderate; flame length low.	2	20
TL8	Timber litter	The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length low.	3	50

FlamMap (Finney 2006) is designed to examine the spatial variability in fire behavior assuming that fuel moisture, wind speed, and wind direction are held constant in time, thereby allowing for more direct comparison of fuel treatment effects. FlamMap's features allow the user to easily characterize fuel hazard and potential fire behavior, as well as analyze fire movement and fuel treatment interactions. The fuel models that were used are estimates of what the fuel loading and fire behavior are currently and what is predicted in the future allowing for vegetation regrowth.

Table 4. Keeney Two weather parameters for high conditions (90th percentile weather) fuel moistures and wind speed

Parameter	Value
1-hour fuel moisture (0 to 0.25 inch diameter)	3%
10-hour fuel moisture (0.25 to 1 inch diameter)	4%
100-hour fuel moisture (1 to 3 inch diameter)	7%
1000-hour fuel moisture (3 inch plus diameter, coarse woody debris)	9%
Herbaceous fuel moisture	32%
Woody fuel moisture	72%
20-foot wind speed	6 miles per hour

The Clean Air Act lists 189 hazardous air pollutants to be regulated. Some components of smoke, such as polycyclic aromic hydrocarbines (PAH) are known to be carcinogenic. Probably the most carcinogenic component is benzo-a-pyrene BaP. Other components, such as aldehydes, are acute irritants. In 1994 and 1997, 18 air toxins were assessed relative to the exposure of humans to smoke from prescribed and wildfires. The five toxins most commonly found in prescribed fire smoke were:

- Particulate matter (PM) - Particulates are the most prevalent air pollutant from fires, and are of the most concern to regulators. Research indicates a correlation between hospitalizations for respiratory problems and high concentrations of fine particulates ($PM_{2.5}$, fine particles that are 2.5 microns in diameter or less). Particulates can carry carcinogens and other toxic compounds. Overexposure to particulates can cause irritation of mucous membranes, decreased lung capacity, and impaired lung function.
- Methane (CH_4) – Methane is an odorless, colorless flammable gas. Short-term exposure to methane may result in feeling tired, dizzy, and headache. There are no long-term health effects currently associated with exposure to methane.

- Carbon monoxide (CO) – Carbon monoxide reduces the oxygen carrying capacity of the blood, a reversible effect. Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain. Exposure can lead to heart attack, especially for persons with heart disease. At very high levels CO can cause dizziness, confusion, unconsciousness and death.
- Nitrogen oxide (NOx) - Nitrous oxide gives rise to nitric oxide (NO) on reaction with oxygen atoms, and this NO in turn reacts with ozone. As a result, it is the main naturally occurring regulator of stratospheric ozone. It is also a major greenhouse gas and air pollutant.. It contributes to global warming, hampers the growth of plants, and can form with other pollutants to form toxic chemicals. Small levels can cause nausea, irritated eyes and/or nose, fluid forming in lungs, and shortness of breath. Breathing high levels can lead to rapid, burning spasms; the swelling of the throat; reduced oxygen intake; a larger buildup of fluids in lungs; or death.
- Sulphur dioxide (SO_2) - Short-term exposure to high enough levels of SO_2 can be life threatening. Generally, exposures to SO_2 cause a burning sensation in the nose and throat. Also, SO_2 exposure can cause difficulty breathing, including changes in the body's ability to take a breath, breathe deeply, or take in as much air per breath. Long-term exposure to sulfur dioxide can cause changes in lung function and aggravate existing heart disease. Asthmatics may be sensitive to changes in respiratory effects due to SO_2 exposure at even low concentrations. Sulfur dioxide is not classified as a human carcinogen (it has not been shown to cause cancer in humans).

Existing Condition

The historical fire regime in the Camp Lick planning area was characterized by frequent fires of low to mixed severity known as fire regime I. Fire behavior within the planning area would have typically been surface fires with average flame lengths less than 4 feet, fireline intensities less than 100 Btu/foot/second, and an occasional small patch of passive crown fire usually less than 20 percent of the stand. Fire return intervals in the blue mountains of Oregon in Mixed conifer forests ranged from 7 to 24 years in drier sites and about 47 years for moister sites. The fires burned in a mixed severity regime with the higher severities in the moister sites (Agee 1996). Past forest practices, including active fire suppression, grazing, and timber harvest have changed the composition and structure of vegetation in the planning area. Current conditions include increases in tree density, encroachment of shade-tolerant tree species, or high loss of shade-intolerant tree species. This creates fuel conditions above historical fire behavior and effects. Current fire behavior conditions under 90th percentile weather conditions are expected to have flame lengths of 4 to 11 feet with some areas exceeding 50 feet, fireline intensities exceeding 100 Btu/foot/second, and a majority of the planning area having passive crown fire. These conditions have created a concern over potential fire behavior, fire effects on public and private lands, and threats to forest resources and potential impacts to air quality.

Camp Lick Fire History

Within the planning area there has been one recorded large fire. This fire occurred in 1910, but there is no data on how the fire started. The fire burned 13,644 acres of which only 792 acres burned within the planning area. During a fifty year period between 1971 -2011 there were 154 small fires within the planning area. The majority of these fires were less than 0.25 acres. Only eight fires were greater than 1 acre, of which the biggest was 25 acres. Of the 154 small fires within the planning area 114 fires had no documented cause. Records indicate that 31 small fires were started by lightning, seven were campfires, one was arson, and one was an escaped debris pile, see Table 5 below.

Table 5. Camp Lick fire history, small fire starts reported from 1971 to 2011.

Cause	number of fires	Average Size (Acres)	Largest Size (Acres)
Unknown*	114	less than 0.1	less than 0.1
Arson	1	0.1	0.1
Campfire	7	1.05	6
Debris Burning	1	0.1	0.1
Lightning	31	1.24	25
Totals	154	0.3	25

Fire Regime and Condition Class

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of Native American burning (Agee 1993, Brown 1995). Coarse scale definitions for natural (historical) fire regimes have been developed by Hardy et al. (2001b) and Schmidt et al. (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001). The five natural (historical) fire regimes are classified based on average number of years between fires (fire frequency) combined with the severity (amount of replacement) of the fire on the dominant overstory vegetation.

These five regimes include:

- I – 0-35 year frequency and low (surface fires most common) to mixed severity;
- II – 0-35 year frequency and high (stand replacement) severity;
- III – 35-100+ year frequency and mixed severity;
- IV – 35-100+ year frequency and high (stand replacement) severity; and
- V – 200+ year frequency and high (stand replacement) severity.

A Fire Regime Condition Class (FRCC) is a landscape classification that describes the amount of departure from the natural (historical) fire regime. They include three condition classes for each fire regime. This departure results in changes to one (or more) of the following ecological components:

- Vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern);
- Fuel composition;
- Fire frequency, severity, and pattern; and
- Other associated disturbances (e.g. insect and disease mortality, grazing, and drought).

All vegetation and fuel conditions or wildland fire situations fit within one of the three classes. The three classes are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural regime. Low departure is considered to be within the natural range of variability, while moderate and high departures are outside. Characteristic vegetation and fuel conditions are considered to be those that occurred within the natural fire regime. Uncharacteristic conditions are considered to be those that did not occur within the natural fire regime. Determination of amount of departure is based on comparison of a composite measure of fire regime attributes, as listed above.

Table 6. Fire regime condition classes

Fire Regime condition class	Description	Species composition and structure	Potential risk
1	Within the natural (historical) range of variability of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances	Species composition and structure are functioning within their natural (historical) range at both patch and landscape scales.	• Fire behavior, effects, and other associated disturbances are similar to those that occurred prior to fire exclusion (suppression) and other types of management that do not mimic the natural fire regime and associated vegetation and fuel characteristics. • Composition and structure of vegetation and fuels are similar to the natural (historical) regime. • Risk of loss of key ecosystem components (e.g. native species, large trees, and soil) is low. • Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe).
2	Moderate departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances	Species composition and structure have been moderately altered from their historical range at patch and landscape scales. For example: Grasslands – Moderate encroachment of shrubs and trees and/or invasive exotic species. Shrublands – Moderate encroachment of trees, increased shrubs, or invasive exotic species. Forestland/Woodland – Moderate increases in density, encroachment of shade tolerant tree species, or moderate loss of shade intolerant tree species caused by fire exclusion, logging, or exotic insects or disease. Replacement of surface shrub/grass with woody fuels and litter.	• Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). • Composition and structure of vegetation and fuel are moderately altered. • Uncharacteristic conditions range from low to moderate. • Risk of loss of key ecosystem components is moderate. • Fire behavior, effects, and other associated disturbances are highly departed (more or less severe).
3	High departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances	Species composition and structure have been substantially altered from their historical range at patch and landscape scales. For example: Grasslands – High encroachment and establishment of shrubs, trees, or invasive exotic species. Shrublands – High encroachment and establishment of trees, increased shrubs, or invasive exotic species. Forestland/Woodland – High increases in density, encroachment of shade tolerant tree species, or high loss of shade intolerant tree species caused by fire exclusion, logging, or exotic insects or disease.	• Composition and structure of vegetation and fuel are highly altered. • Uncharacteristic conditions range from moderate to high. • Risk of loss of key ecosystem components is high

Currently, 90 percent of the Camp Lick planning area falls within FRCC class 3, which is characterized by a high departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances. Species composition and structure have been substantially altered from their historical range at patch and landscape scales, uncharacteristic conditions range from moderate to high, and risk of loss of key ecosystem components is high.

Air Quality

According to the Environmental Protection Agency (EPA) Green Book updated September 22, 2016, the closest designated nonattainment area is the city of Klamath Falls, Oregon which is 223 air miles from the Camp Lick planning area. The community of John Day is listed in the Oregon Smoke Management Plan as a smoke-sensitive receptor area, and thus protected by the highest standard in the plan. The Strawberry Mountain Wilderness is a class 1 airshed within 20 air miles of the planning area.

Air quality current conditions in surrounding sensitive areas is limited to short-term impacts resulting from wood burning, prescribed burning, and field burning. The greatest impact to the wilderness area is from field burning in the Willamette Valley and central Oregon and from summer wildfires that occur to the south and west. These sources contribute to haze and can last for several days in spring and summer.

Desired Condition

The desired condition would be to restore and maintain an ecosystem that will thrive with the recurring disturbance of wildfire within the planning area, and decrease the probability of catastrophic effects of wildland fire. Specifically, this means a reduction in surface fuels, duff/litter depth, ladder fuels, and crown bulk density; an increase in canopy base heights; and the stimulation of the growth of aspen and other fire-adapted vegetation. Both mechanically-treated and untreated stands would be exposed to prescribed burning as fire is re-introduced into the planning area.

The desired condition from a fire behavior standpoint would be a surface fire with average flame lengths less than 4 feet and minimal passive crown fire in the planning area averaging less than 20 percent at the stand level and an average fireline intensity of less than 100 Btu/foot/second. The desired condition would be a safe environment for firefighters, forest visitors, and the public; strategic fuel zones along designated roadways; and fire reestablished to its natural role in the ecosystem. This desired condition would be achieved while continuing to provide habitat for wildlife species dependent upon late and old forest with areas of low fuel loadings, reduced fire behavior, and increased safety and suppression tactics. Less biomass would be available to burn under a wildfire thereby reducing potential health hazards from smoke emissions. Less greenhouse gasses would be released in the planning area during a wildfire event which would not significantly contribute to climate change.

Environmental Consequences

Spatial and Temporal Context for Effects Analysis

The spatial context for the effects analysis is the geographic treatment area boundary. The project is located on the Blue Mountain Ranger District (BMRD) within the Malheur National Forest. The planning area is located in Grant County, approximately 10 miles northeast of the city of John Day, Oregon. The Camp Lick planning area encompasses approximately 40,000 acres in the

Upper Camp Creek, Lower Camp Creek, and Lick Creek subwatersheds that drain into the Middle Fork John Day River. The main road access to the planning area is via County Road 18 off U.S. Highway 26 from east of the planning area and County Road 20 off State Route 7 from the north.

The legal description for the planning area is (township, range, sections):

- T. 10 S., R. 32 E., sec. 19-36;
- T. 10 S., R. 33 E., sec. 18, 19, 30-32;
- T. 11 S., R. 32 E., sec. 1-36; T. 11 S., R. 33 E., sec. 4-10, 15-22, 28-32; and
- T. 12 S., R. 32 E., sec. 1-5, 8-12, Willamette Meridian.

The Camp Lick planning area ranges in elevation from 3,500 feet at the northern boundary of the planning area at the confluence of Camp Creek and the Middle Fork John Day River to 6,300 feet at the eastern boundary.

Direct and indirect effects would happen as the proposed treatments are implemented. The time period for indirect and cumulative effects analysis is 30 years, regardless of the alternative. From a fuels perspective, the number of stand structure possibilities would be difficult if not impossible to quantify with any type of certainty beyond 30 years. Project implementation would begin in the fall of 2018 and may continue for about twenty years; however, vegetation would continue to grow and maintenance would be needed to maintain the desired condition.

The air quality analysis considers potential impacts to communities within 20 miles of the planning area as these are the communities that would be most impacted by any activities within the alternatives. The temporal bounds are limited to the implementation phase of the project as direct, indirect, and cumulative effects would be limited to the timeframe in which proposed activities would occur.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

The direct, indirect, and cumulative effects analyses are based on a temporal scale. Documented past projects, including timber harvesting, wildfires, watershed improvements, and other activities described in Appendix E: Past, Present, and Reasonably Foreseeable Future Actions of the Camp Lick EA ranging as far back as 1860s were considered past actions within the analysis area. This vegetation structure and composition includes attributes of the current landscape including existing vegetation types, fuel treatments, burned areas, past sanitation harvest, and plantations.

In order to understand the contribution of past actions to the cumulative effects of the proposed action and alternatives, this analysis relies on current environmental conditions as a proxy for the impacts of past actions. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects.

This cumulative effects analysis does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. Focusing on individual actions would be less accurate than looking at existing conditions, because there is limited information on the environmental impacts of individual past actions, and it is not reasonably possible to identify every action over the last century that has contributed to current conditions. By looking at current conditions, the Forest Service is sure to capture all the residual effects of past human actions and natural events, regardless of which particular action or event contributed those effects. The

Council on Environmental Quality issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which states, “agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions.” For these reasons, the analysis of past actions in this section is based on current environmental conditions.

Present activities within the planning area that will have a cumulative effect on the alternatives are the County Road 18 Healthy Forest Restoration Act Project, plantation maintenance, present grazing, and firewood cutting.

The County Road 18 Healthy Forest Restoration Act Project is adjacent to and overlaps the southwestern project boundary. The project is treating designated fuel breaks created adjacent to County Road 18. Approximately 1,200 acres were commercially thinned and 1,600 acres were non-commercially thinned. Prescribed burning along this corridor is ongoing. The treatments will complement the planning area by reducing fire behavior and fire effects as well as creating safe travel routes along a main road within the project boundary.

Plantation maintenance is occurring throughout the planning area treatments include stand improvement biomass thinning and handpiling on approximately 3,640 acres. The thinning is within plantations from previously harvest units of a variety of timber sales. These timber sales are listed in Appendix E of the Camp Lick EA under Past timber harvest. The treatments will complement the planning area by reducing fire behavior and fire effects.

Grazing is occurring within approximately 37,750 acres of the project boundary. Grazing will continue to affects fine fuels, which can impact the implementation of prescribed fire and meeting objectives if it removes the fuel (grasses) to carry fire.

Firewood cutting is occurring throughout the planning area. The removal of dead trees reduces fire behavior and fire effects.

Alternative 1 – No Action

Under alternative 1, silvicultural treatments with associated activity fuel treatments would not be implemented. This alternative would not authorize fuels reduction, leaving the planning area at risk of an uncharacteristically severe fire. The escape routes along roads would be unsuitable for safe egress or as a fire suppression tool or safety area for firefighters. No silvicultural treatments or fuels reduction activities would take place in the planning area. Prescribed fire would not be implemented within the planning area. Custodial activities would continue, such as routine maintenance and response to emergencies, including wildfire suppression.

Direct and Indirect Effects

No action implies conditions within the planning area might remain static. This assumption would be incorrect since forest ecosystems are dynamic and would continue to produce vegetation that competes for available sunlight, moisture, and nutrients. As time progresses, the conifer stands would produce heavier understories of shade-tolerant, fire-intolerant trees (fuel ladders), dead/down woody debris would continue to accumulate, and mortality would increase, creating the potential for a large, catastrophic fire event. Hazardous fuel conditions within the planning area would remain untreated and constitute a potential wildfire threat, not only for the proposed planning area, but also for adjacent lands.

Surface fuel loadings would increase over time as shrubs grow and competition-created snags fall. Although competition would naturally thin the stand, shade-intolerant species would continue to grow in the understory. This would keep height to live crown low and crown density high. The large fire resistant trees in the stand would remain as long as they successfully compete for limited resources. These trees would continue to be competition-stressed and at risk from insects, disease, and wildfire.

There would be no change to the road system under this alternative. Therefore, the use of strategic fuelbreaks along roads as ingress/egress routes during a wildfires would remain the same as current conditions.

Since no silvicultural or fuel treatments would be implemented, only natural changes, including the effects of ongoing fire suppression, would result in changes to the fuel profile within the planning area. This includes continued growth in the understory, snag creation, and dead and down material accumulation. This alternative would not change expected fire behavior under 90th percentile weather conditions.

Historically, fires in the planning area were low intensity with less than 20 percent of the stand being killed by fire. Fire effects under the alternative 1 would result in higher stand loss as seen in the Canyon Creek Complex fire which burned in similar fuels profiles on the Malheur National Forest in 2015. It is expected that some fires, both human and lightning caused, would continue to escape initial attack under increasingly severe weather conditions over the next 20 to 30 years. These fires are expected to kill forest stands, including larger trees.

There is no significant change in expected fire behavior on the landscape in the short-term. Stands would continue to be at risk from stand replacement fire. With continued surface fuel accumulation it is likely surface fire intensity and crown fire potential would increase over the long-term.

Wildfire starts currently have the potential to produce severe stand replacement type fires under severe fire weather conditions as seen in the Canyon Creek Complex fire, presenting a threat to firefighters and the public. Alternative 1 would do nothing to mitigate this situation, allowing the already hazardous fire conditions to increase going into the future.

Table 7 displays predicted flame lengths, fireline intensities, crown fire activity, and suppression actions under 90th percentile weather conditions for alternative 1. Under alternative 1, average flame lengths are expected to exceed 4 feet (Figure 3) . Currently, fireline intensities exceed 100 Btu per foot per second (Figure 2) and the majority of the planning area can sustain passive crown fire (Figure 1). These increased flame lengths, intensities, and passive crown fire are a direct result of high fuel loadings and high stocking levels. Fires burning in stands under 90th percentile weather conditions in alternative 1 are expected to result in control problems and high tree mortality.

Table 7. Alternative 1 predicted average surface fire flame length, fireline intensity, crown fire activity, and suppression action under the 90th percentile weather condition.

Flame length (feet)	Fireline intensity (Btu/feet/second)	Crown fire activity	Suppression actions
4-8	100-500	Passive crown fire	Fires may present serious control problems torching, crowning, and spotting. Control efforts at the fire head would probably be ineffective.

The no action alternative would have the least immediate impact on air quality, as there would be no prescribed burning or pile burning. All biomass would remain available for consumption by wildfires and would continue to accumulate, increasing the potential for large amounts of smoke during the summer months, when diurnal inversions can concentrate smoke at low elevations. Because wildfires tend to occur at the driest time of the year, fuels are more completely consumed and typically produce three to five times more emissions than early or late season prescribed fires. There is a potential during a wildfire for approximately 990 pounds per acre of $PM_{2.5}$ emissions. These smoke concentrations can have high particulate levels that can cause health problems, or violate summertime class I air quality visibility standards for wilderness areas. The communities of Long Creek, Fox, Galena, Prairie City, Unity, and John Day would be impacted by smoke from a wildfire in this area.

Cumulative Effects

The outcome of the no action alternative would result in increased fuel loading. The increase in fuel loading would result in increased fire behavior and would allow larger and more intense fires to impact the treatments from other projects on private and National Forest System lands.

Availability of strategic points to control wildfires on the landscape would be reduced due to higher fire behavior. Foot travel for fire suppression would be hampered due to increased fuel loading and unsafe working conditions. Surface fuel accumulation and higher canopy loading may limit fire management suppression opportunities.

Alternative 2 – Proposed Action

The proposed action includes a suite of activities (silvicultural treatments; riparian and upland watershed restoration treatments; prescribed burning and unplanned ignitions; road use, road maintenance, and temporary road construction; road system changes, interpretive sign installation; and range fence construction) to move forest stands toward resilient conditions, restore fire-adapted ecosystems, reduce ladder and surface fuels, reduce the impacts of roads and ungulates to riparian areas, improve fish and wildlife habitat, and improve aspen stands while providing wood products on a sustained yield basis. Prescribed fire would burn approximately 32,080 acres, of which approximately 235 acres are outside of the planning area boundary. Expanding these prescribed fire boundaries to natural fuel breaks and roads increases firefighter safety and limits resource damage created by constructing new containment lines.

Fuels treatments

Following stand improvement thinning or riparian upland watershed restoration, one or a combination of fuels treatments may be implemented to reduce fuel loading within approximately 8,800 acres. These treatments may include handpiling, machine piling, pile burning, jackpot burning, underburning, lop and scatter, and mastication. Not all of these treatments would need to be implemented on every acre to achieve desired outcome.

Prescribed burning and unplanned ignitions would occur in 23 prescribed fire burn blocks which vary in size from approximately 300 to 3,500 acres with boundaries identified along natural fuel breaks, such as existing roads and ridgetops. The size, in acres, of a particular burn block does not represent how much of the landscape would be burned or blackened. Within each identified burn block there would be a number of unburned acres. Examples include open scabby areas, wet riparian areas, and north facing slopes. Additionally, much of the area where prescribed fire would carry is expected to burn in a mosaic pattern due to variations such as fuel moisture, shading, grazing, lack of continuous fuelbeds, and others. Another factor limiting actual burned acres is design criteria limiting where active ignitions can occur within a particular burn block. Depending on weather conditions, fuel characteristics, and design criteria, the number of acres burned could vary from 50 to 80 percent of the proposed burn block size.

The following describes common fuel treatment types and the conditions under which they may be implemented:

Jackpot burning: A modified form of underburn or broadcast burn where the target fuels to be ignited are the concentrations (or jackpots) of vegetative fuel. The result is a mosaic burn pattern. This technique works well when surface fuels loading is very high but not continuous following vegetation treatments.

This treatment can be done spring or fall depending on the size of fuels needing to be reduced. Spring targets smaller diameter material less than 3 inches and retains much of the larger than 3 inch material. Fall burning would consume more material in all size classes.

This treatment can be done immediately post-harvest or as one of the last treatments in the unit.

Underburning: A prescribed fire ignited under the forest canopy, via natural ignition or human, and focuses on the consumption of surface fuels but not the overstory vegetation. Underburning is generally used following a pre-treatment such as harvesting, thinning and /or pile burning to further reduce the surface fuels, help maintain the desired vegetation conditions and enhance the overall health and resiliency of the stand.

This treatment can be done spring or fall depending on the size of fuels needing to be reduced. Spring targets smaller diameter material less than 3 inches and retains much of the larger than 3 inch material. Fall burning would consume more material in all size classes.

This treatment can be done immediately post-harvest or as one of the last treatments in the unit.

Pile burning: A prescribed fire used to ignite hand or machine piles of cut vegetation resulting from vegetation or fuel management activities.

Piles are generally burned during the wet season to reduce damage to the residual trees and to confine the fire to the footprint of the pile. Pile burning allows time for the vegetative material to dry out and will produce less overall smoke by burning hot and clean.

Pile burning treatments need to be implemented within one year of cutting treatment to be most efficient as needles start to fall off making piles harder to burn.

Hazard tree felling: Falling/cutting trees that pose a threat to forest visitors, contractors, and firefighters.

Hazard tree felling would happen anytime a hazard tree was recognized.

Handpile: Piles would be constructed post timber harvest and after stand improvement biomass thinning work. A pile of slash constructed by a crew, not by machine. Handpiles are typically less than 10 feet high and less than 12 feet in diameter. Piles would be post timber harvest and secondary thinning work. Piling takes place during the field season (spring, summer, or fall).

Machine Pile: A mechanical type treatment. Piles of slash (vegetative debris from hazardous fuel reduction projects) constructed using vehicular machines of such size and at such distance from trees so that burning shall not result in unnecessary damage to residual timber, Piling takes place during the field season (spring, summer, or fall).

Lop and Scatter: Cutting branches, tops, and unwanted boles into lengths and spreading debris more or less evenly over the ground. This includes logging slash or fuel reduction debris cut and or scattered to reduce slash concentrations. Slash is scattered into openings away from and without unnecessary damage to residual trees. Lop and scatter can occur anytime but is usually implemented post thinning operations. Lop and scatter is also used when there is not enough ground fuels to carry a fire to enhance prescribed fire objectives.

Mastication: A mechanical type treatment. Chopping, grinding, and/or mowing treatments, usually by mechanical means, to reduce fuel bed depth or crowning potential. The primary target is usually live fuels, such as brush and small trees, but can be used in light loadings of dead fuels. Vegetation is usually left in place.

Direct and Indirect Effects

Silvicultural and fuels treatments have the effect of increasing the height to live crown and retaining the largest trees which reduces crown fire initiation. Crown density is also reduced, lowering active crown fire potential. The surface fuel treatments change the size and arrangement of available fuel and/or reduce the amount of fuel that is available to burn, reducing flame lengths, fireline intensities, and crown fire activity.

Treatments would reduce the horizontal and vertical fuel loading. Direct attack with hand tools would be sufficient to contain fires. Fire could be reintroduced into the planning area. The strategic fuelbreaks along roads would allow safe travel for the public and suppression forces should the need arise to escape from an emerging wildland fire.

In order to sustain the desired fuels strata, follow-up treatments would be necessary to maintain fuel loading levels. Conditions would be evaluated and prescribed following implementation (anticipated to be 15 to 20 years after initial entry). These maintenance treatments can include:

- Prescribed burning (jackpot, underburn, piles) lowers fuel loading in all size classes;
- Felling of hazard trees reduces the risk to firefighters and the public from trees falling;
- Mastication reduces fuel bed depth and breaks up fuel continuity; and
- Piling excess fuels breaks up fuel continuity.

Thinning trees from below would raise canopy base heights, thereby reducing crown fire initiation which would increase the likelihood that fire would stay as surface fires and not become crown fires. Surface treatments should lower fireline intensities and lower flame lengths. Suppression forces could enter these areas and take appropriate actions as needed to manage fires

(Brown et al. 2003). The treatments in alternative 2 are expected to slow horizontal and vertical fire movement in 90th percentile weather conditions.

Creating and maintaining strategic fuelbreaks to break up large expanses of continuous fuels would provide for firefighter access and safety, increase suppression opportunities, increase ingress and egress safety for communities, and provide pre-existing control points to contain fires.

Table 8 displays predicted flame lengths, fireline intensities, crown fire activity and suppression actions. Under alternative 2, flame lengths average 4 feet (Figure 6). Fireline intensities on average would not exceed 100 Btu per foot per second (Figure 5). Crown fire activity on average would be kept to surface fires (Figure 4). These lower flame lengths, fireline intensities, and surface fires are a direct result of lower fuel loadings, lower canopy bulk densities, and higher canopy base heights. Fires burning in stands under 90th percentile weather conditions in alternative 2 can generally be attacked at the head or flanks by persons using hand tools. Fire behavior and effects would be similar to historical conditions within fire regime 1 allowing for fire to burn naturally within the planning area. The effect on fire suppression forces would depend on the continued maintenance of the stands. Stands that are maintained and managed to achieve the desired condition would not adversely impact future suppression.

Table 8. Alternative 2 predicted average surface fire flame length, fireline intensity, crown fire activity, and suppression action under 90th percentile weather conditions

Alternative 2	Flame length (feet)	Fireline intensity (Btu/feet/second)	Crown fire activity	Suppression actions
Post-activity	≤4	≤100	Surface fire	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.

* Continued maintenance and prescribed fire rotation.

Prescribed burning would follow the guidance provided by the Oregon Smoke Management Plan and all other applicable federal, state, and local air quality regulations. Emissions from a wildfire are generally three to five times more than from prescribed burning. Emissions from pile burning would be during a different time of year than the underburning. There would be short-term impacts to communities and residences downwind and in drainages adjacent to prescribed fire. There would also be short-term impacts along County Road 20. The low elevation communities of Galena, Austin, and Bates would be impacted by smoke from prescribed burning. Past experience of prescribed burning in this area has shown that diurnal winds settle smoke in low areas and valley bottoms. During the night, air follows drainages in the valley toward Galena. During the day, diurnal heating forces air up through the valley and up the slope out of the valley toward Bates and Austin.

Prescribed burning would likely impact highway visibility, and potentially impact driver safety. Signing would reduce the risk, lasting for around three to four days. If driving conditions warrant, the Oregon Department of Transportation or Grant County road department would be contacted to flag traffic or use pilot cars.

Emissions produced from burning under the proposed action would maintain air quality standards. There is a potential for cumulative effects from prescribed burning occurring at the same time from nearby units. Currently, three projects are located near the Camp Lick Project (the Galena, Big Mosquito, and Balance projects), and NEPA should be signed for the Magone and Ragged Ruby projects within the next 3 years. Total emissions produced from concurrent projects on National Forest System lands would meet air quality standards. It is likely that only a few projects, in isolated areas, would undergo burning at the same time. The dilution of smoke over time and space from concurrent burning would limit the cumulative effects. All burning would be coordinated to reduce cumulative effects and meet all applicable laws and regulations. Therefore, the cumulative effects of multiple prescribed burning projects would not cause air quality to decline outside of standards.

Smoke sensitive areas, John Day (approximately 20 air miles southwest of the planning area), the La Grande Basin (approximately 45 air miles to the northeast of the planning area) and the north half of Ada County, Idaho (approximately 160 air miles southeast of the planning area) may be affected by prescribed burning because of transport winds, but it is expected to be minimal because of smoke dilution over time and space. Weather forecasts would be obtained prior to burning to ensure the Strawberry Mountain Wilderness would not be affected by prescribed burning during the visibility protection periods of July 1 to September 1.

Table 9. Smoke emissions comparison from a wildfire under 90th percentile weather within treatment units and prescribed burning

Toxins	Alternative 1 (tons)	Alternative 2 prescribed fire (tons)	Alternative 2 wildfire (tons)	Alternative 2 total (tons)
PM_{10}	17,644	3,673	4,652	8,325
$PM_{2.5}$	14,949	4,732	3,946	8,678
CH_4	8,822	1,829	2,326	4,154
CO	189,464	38,672	49,692	88,364
CO_2	1,367,009	326,767	371,647	698,414
N_2O	1,091	321	321	642
SO_2	978	241	273	513

Table 10. Greenhouse gas emissions comparison from a wildfire under 90th percentile weather within treatment units and prescribed burning

Alternatives	CH4*	CO2*	N20*	Total
1: Wildfire	8,822	1,367,009	1,091	1,376,922
2: Wildfire and prescribed fire	4,154	698,414	642	703,210

*CO_2 equivalent metric tons.

Impacts from the riparian and upland watershed restoration treatments would be similar to those described above in terms of reducing flame lengths, fireline intensities, crown fire activity, and suppression actions. Additionally, a healthy riparian area acts as a natural fuel break to slow and help stop a wildfire. There would be short-term (5 to 10 years) adverse effects on fuel loadings in the riparian areas where woody debris are placed in the stream and until conifer slash loads are reduced. Underburning in the riparian areas would stimulate the growth of hardwoods and reduce conifer encroachment.

Planned road activities would have little effect on fire suppression efforts or fuel loading. Many of the roads in the planning area would remain open; however, some roads would be closed but available for fire suppression activities. The roads planned for decommissioning would not have a major affect for fire suppression access. Roads proposed for decommissioning were evaluated and determined to be not needed for suppression activities.

Interpretive sign installation would not affect fuel loading because it would be installed along an existing road. However, increased opportunities for recreation in the planning area may have an indirect effect as additional recreationists could lead to more human caused fires.

There would be no direct or indirect effects from the range fence construction because this activity would not affect fuel loading.

Cumulative Effects

Treatments from this project when combined with the County Road 18 Healthy Forest Restoration Act Project, plantation maintenance and firewood cutting activities would improve stand survivability during a wildfire event by reducing canopy bulk density, canopy base heights, and fuel loading. Treatments would increase firefighter and public safety along designated roads within the planning area. In the event of a wildfire the planning area would be conducive to allow a fire to run its historical course.

Roads are commonly used as a control point for containing wildfire and are often used as the fireline. Fuels treatments would provide a continual break in the fuel profiles crossing the planning area. This fuels treatment when combined with existing projects would further break up fuel continuities in the area, creating more opportunities for future suppression actions. As managers continue to move the forest toward the desired condition, fire would be able to resume its natural role in developing and sustaining these ecosystems. Continued management practices can and will alter the effects of wildland fire (Agee and Skinner 2005).

Present activities within the planning area that would have a cumulative effect on the alternatives are the County Road 18 Healthy Forest Restoration Act Project, plantation maintenance, present grazing, and firewood cutting.

The County Road 18 Healthy Forest Restoration Act Project is adjacent to and overlaps the southwestern project boundary. The project is treating designated fuel breaks created adjacent to County Road 18. Approximately 1,200 acres were commercially thinned and 1,600 acres were non-commercially thinned. Prescribed burning along this corridor is ongoing. The treatments will complement the planning area by reducing fire behavior and fire effects, as well as creating safe travel routes along a main road within the project boundary.

Plantation maintenance is occurring throughout the planning area treatments including stand improvement biomass thinning and handpiling on approximately 3,640 acres. The thinning is within plantations from previously timber harvest units. These timber sale units are listed in Appendix E of the Camp Lick EA under past timber harvest. The treatments will complement the planning area by reducing fire behavior and fire effects. Flame lengths are expected to be below four feet, fire activity would be a surface fire, fireline intensities of less than 100 Btu/foot/second at the head of the fire. As there are less fuels there would be lower emissions which would increase health and safety as well as not contribute significantly to climate change.

Grazing is occurring within approximately 37,750 acres of the project boundary. Grazing will continue to affect fine fuels. This can impact the implementation of prescribed fire and meeting objectives if it removes the fuel (grasses) to carry fire.

Firewood cutting is occurring throughout the planning area. The removal of dead trees reduces fire behavior and fire effects.

Comparison of Alternatives

There would be a sizable reduction in flame length and crown fire activity within the planning area with the proposed action compared to the no action alternative.

Table 11. Approximate acre comparison of flame length by alternative

Flame length (feet)	No action (acres)	Proposed action (acres)
0-4	18,321	34,938
4-8	16,187	3,671
8-11	4,135	930
11+	1,187	291

Table 12. Approximate acre comparison of crown fire activity by alternative

Crown fire activity	No action (acres)	Proposed action (acres)
Surface fire	15,070	33,854
Passive crown fire	24,759	5,974

Table 13. Approximate acre comparison of fireline intensity by alternative

Fireline intensity (Btu/ft/sec)	No action (acres)	Proposed action (acres)
0-100	9,871	27,673
101-500	14,614	8,550
501-1000	11,529	2,725
1001+	3,824	891

Compliance with Forest Plan and Other Relevant Laws, Regulations, and Policies

The no action alternative is not in compliance with the Malheur Forest Plan and the above regulatory framework. The no action alternative would not allow prescribed fire to play a natural role in the planning area. Fire behavior would not be a low intensity surface fire over the majority of the planning area. The no action alternative would not manage residue profiles and fire would have the potential to be an uncharacteristically severe wildfire. The no action alternative would not use prescribed fire to reduce encroachment of non fire tolerant species, stocking levels, and fuel loading; this would change the natural fuels strata in riparian, big game, and old growth areas, potentially losing key features in these areas. The no action alternative would not use fuels treatments in developed recreation sites and visual corridors; this would potentially create safety concerns from high fuel loadings and decreased site distances. The no action alternative would not preserve, protect, and enhance the air quality during wildfire events. The no action alternative does not meet the Grant County CWPP goals to reduce hazardous fuels.

The proposed action is in compliance with the regulatory framework. After treatments from the proposed action flame lengths across the planning area would average less than 4 feet, fireline intensities would be below 100 Btu/foot/second, fires would burn as surface fires, and less emissions would be produced during a wildfire event.

References

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Washington, DC: Island Press. 433 p.

Agee, J.K. 1996. Fire in the Blue Mountains: a history, ecology, and research agenda. Chapter 7 (pages 119-145) in Jaindl, Raymond and Quigley, Thomas M.(editors): Search for a solution: sustaining the land, people, and economy of the Blue Mountains. Washington, D.C.: American Forests in cooperation with the Blue Mountains Natural Resources InstituteAndrews, P.L. and R.C. Rothermel. 1982. Charts for interpreting wildland fire behavior characteristics. PMS-435-2, NFES#0274. Washington, DC: National Wildfire Coordinating Group. 21 p.

Agee, J.K. and C.N. Skinner. 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management, 211, pp.83-96.

Andrews, P.L., F.A. Heinsch, and L. Schelvan. 2011. How to generate and interpret fire characteristics charts for surface and crown fire behavior. General Technical Report RMRS-GTR-253. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 40 p.

Blonski, K.S. and J.L. Schramel. 1981. Photo series for quantifying natural forest residues: southern Cascades, northern Sierra Nevada. General Technical Report PSW-56. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 145 p.

Brown, J.K. 1995. Fire regimes and their relevance to ecosystem management. Pages 171-178. In Proceedings of Society of American Foresters National Convention, Sept. 18-22, 1994, Anchorage, AK. Society of American Foresters, Washington DC.

Brown, J.K., E.D. Reinhardt, and K.A. Kramer. 2003. Course woody debris: managing benefits and fire hazards in recovering forest. Gen. Tech. Rep. RMRS-GTR-105. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 16 p.

DeBano, L.F., D.G. Neary, and P.F. Ffolliott. 1998. Fire effects on ecosystems. John Wiley & Sons, Inc.

Enrong Y., W. Xihua, and H. Jianjun. 2006. Concept and classification of coarse woody debris in forest ecosystems. Frontiers of Biology in China 1(1): 76-84.

Finney, M.A. 2006. An overview of FlamMap fire modeling capabilities. Pages 213-220. In: Andrews, P.L. and B.W. Butler (comps.). 2006. Fuels management-how to measure success: conference proceedings. 28-30 March 2006; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Franklin, J.F. and J.A. Agee. 2003. Forging a science-based national forest fire policy. Issues in Science and Technology 20: 59-66.

Grant County Community Fire Protection Plan. 2005. Grant County, OR.

Hann, W.J. and D.L. Bunnell. 2001. Fire and land management planning and implementation across multiple scales. International Journal of. Wildland Fire 10: 389-403.

Hardy, C.C., R.D. Ottmar, J.L. Peterson, J.E. Core, and P. Seamon. 2001a. Smoke management guide for prescribed and wildland fire. 2001 Edition PMS 420-2 NFES 1279.

Hardy, C.C., K.M. Schmidt, J.M. Menakis, and N.R. Samson. 2001b. Spatial data for national fire planning and fuel management. International Journal of Wildland Fire 10: 353-372.

Maxwell, W.G. and F.R. Ward. 1980. Photo series for quantifying natural forest residues in common vegetation types of the Pacific Northwest. General Technical Report PNW-GTR-105. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Available online: https://www.fs.fed.us/pnw/publications/pnw_gtr105/

Maxwell, W.G. and F.R. Ward. 1979. Photo series for quantifying forest residues in the: sierra mixed conifer type, sierra true fir type. General Technical Report PNW-GTR-095. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 79 p. Available online: https://www.treesearch.fs.fed.us/pubs/5597

Schlobohm, P. and J. Brain. 2002. Gaining and understanding of the national fire danger rating system. PMS-932, NFES#2665. May, 2002. Washington, DC: National Wildfire Coordinating Group. 71 pages.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J. Hann, and D.L. Bunnell. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. General Technical Report RMRS-GTR-687. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Schoennagel, T., T.T. Veblen, and W.H. Romme. 2004. The interaction of fire, fuels, and climate across Rocky Mountain forests. BioScience 54: 661–76.

Scott, J.H. and R.E. Burgan. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. General Technical Report RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

USDA Forest Service. 1990. Malheur National Forest Land and Resource Management Plan. John Day, OR. Available online: http://www.fs.usda.gov/detail/malheur/landmanagement/projects/?cid=fsbdev3_033813

USDA Forest Service. 2000. Protecting People and Sustaining Resources in Fire-adapted Ecosystems—A Cohesive Strategy. Available online at: http://www.fs.fed.us/publications/2000/cohesive_strategy10132000.pdf

USDA Forest Service. 2013. Malheur National Forest Fire Management Plan. USDA Forest Service, Malheur National Forest, John Day, Oregon.

USDA and USDI 1995. Federal wildland fire management policy and program review. Available online: https://www.forestsandrangelands.gov/strategy/documents/foundational/1995_fed_wildland_fire_policy_program_report.pdf

USDA and USDI. 2000. Managing the impacts of wildfire on communities and the environment: a report to the President in response to the wildfires of 2000 (National Fire Plan).

Available online:
https://www.forestsandrangelands.gov/resources/reports/documents/2001/8-20-en.pdf

Appendix A – Maps

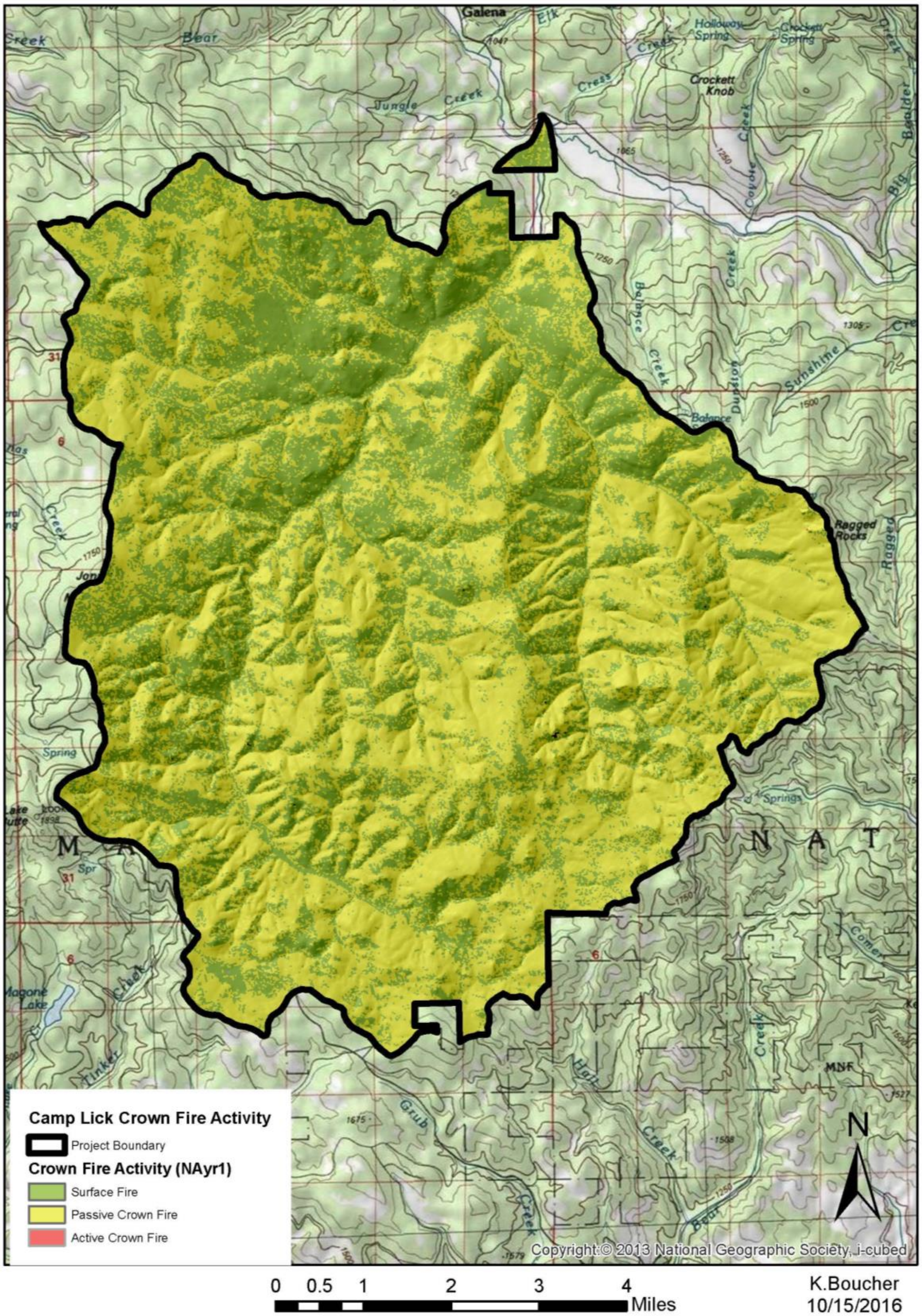

Figure 1. Expected crown fire activity expected with the no action alternative (alternative 1)

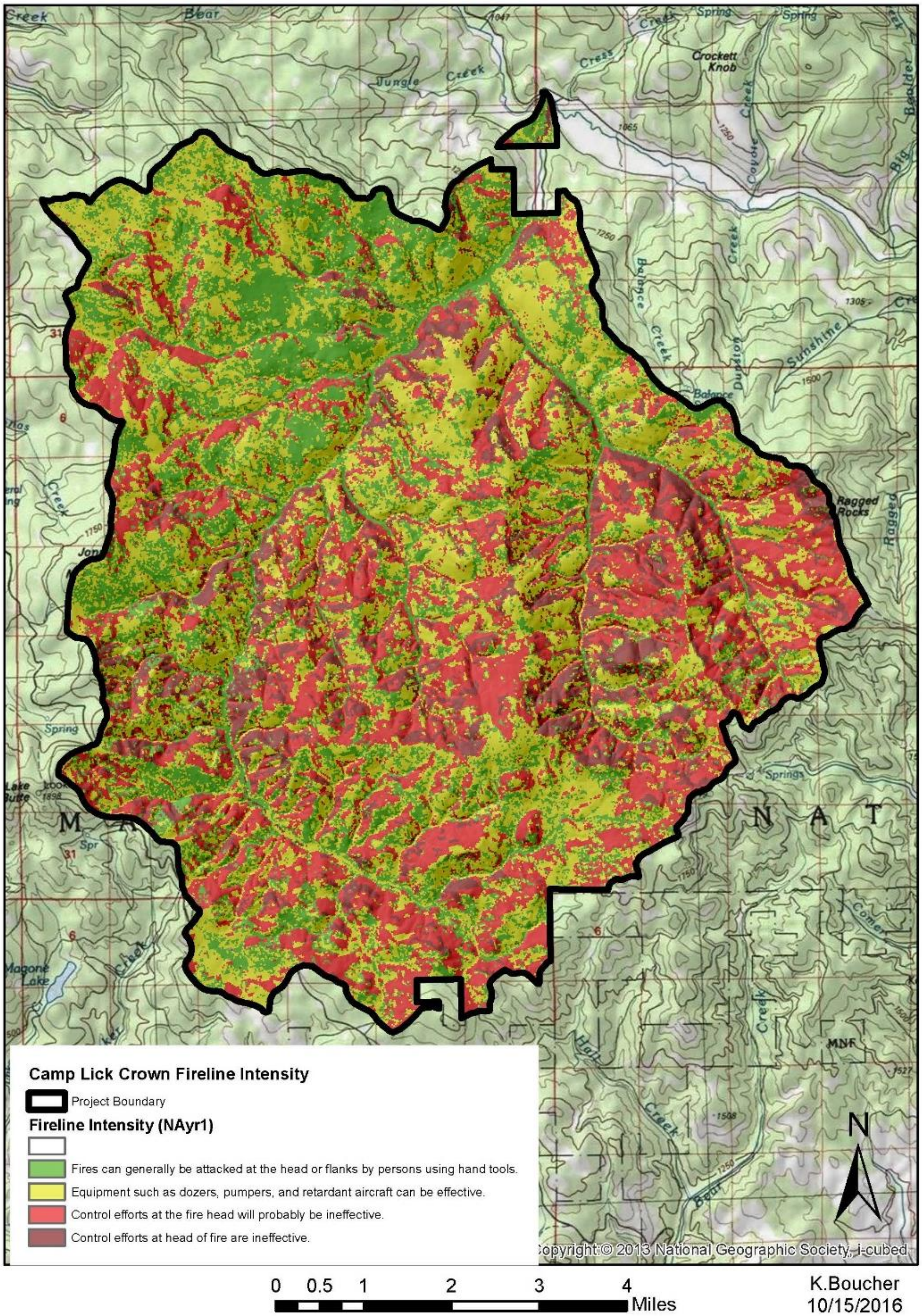

Figure 2. Fireline intensity expected under the no action alternative (alternative 1)

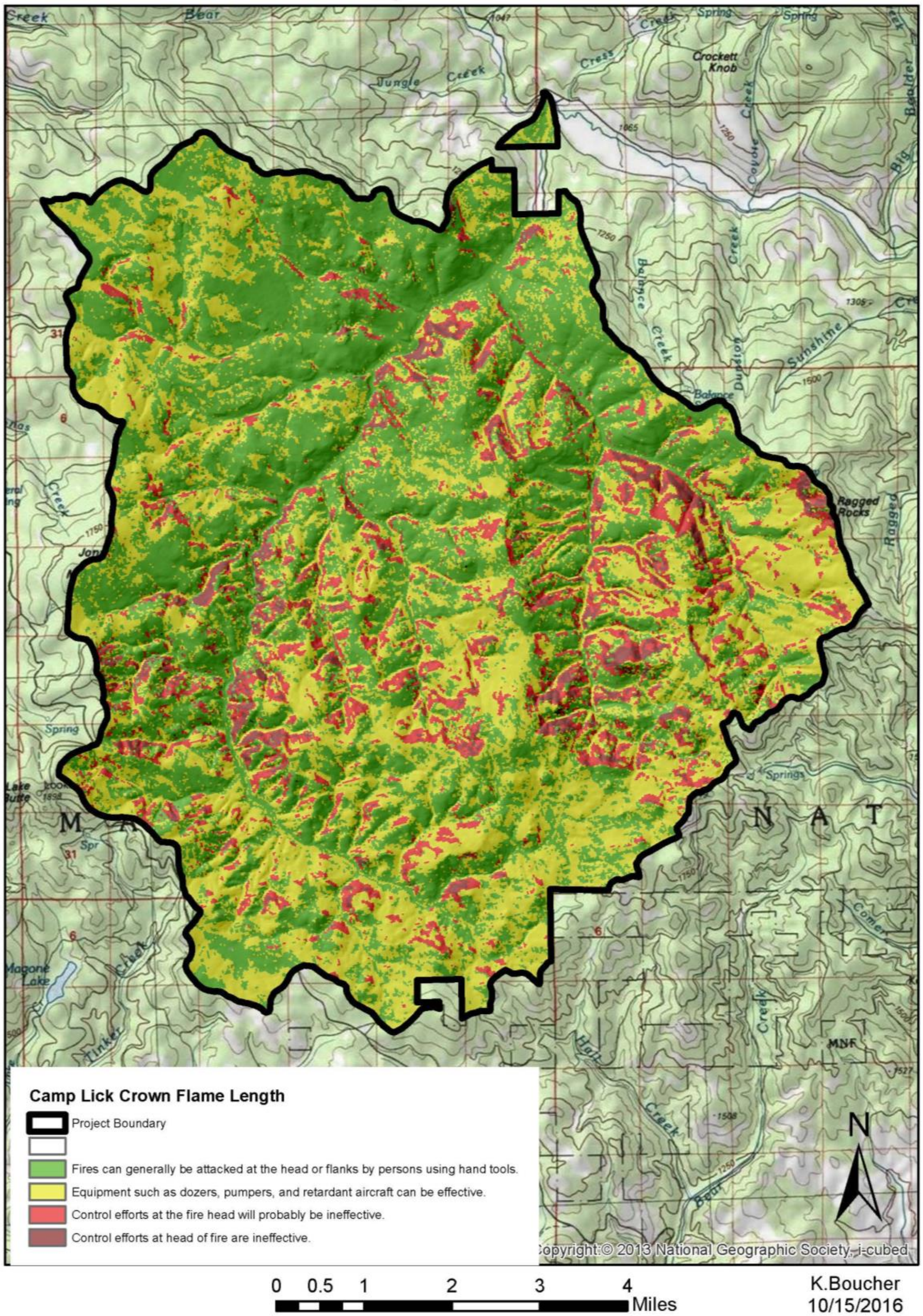

Figure 3. Expected flame length with the no action alternative (alternative 1)

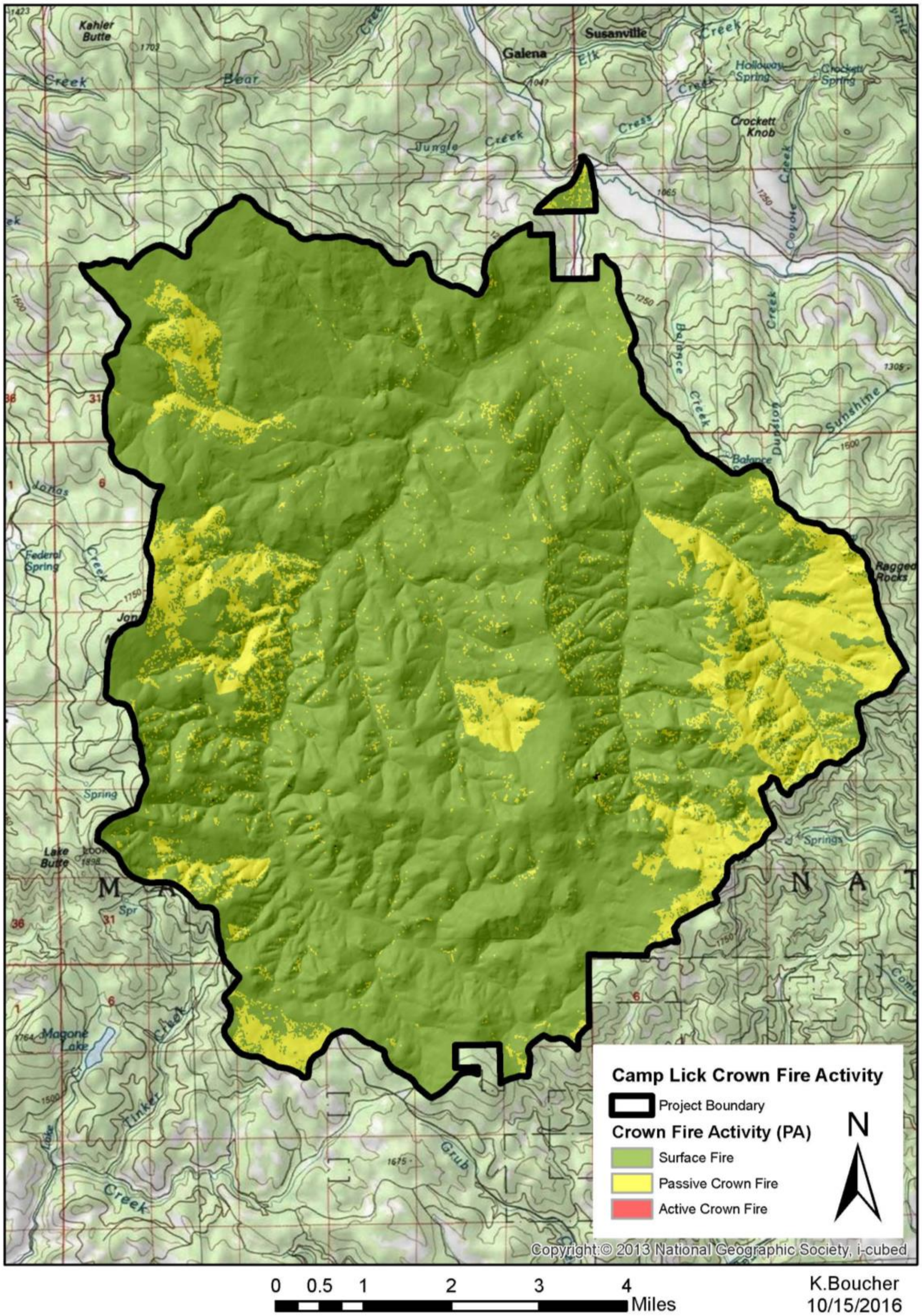

Figure 4. Expected crown fire activity with the proposed action (alternative 2) post-treatment

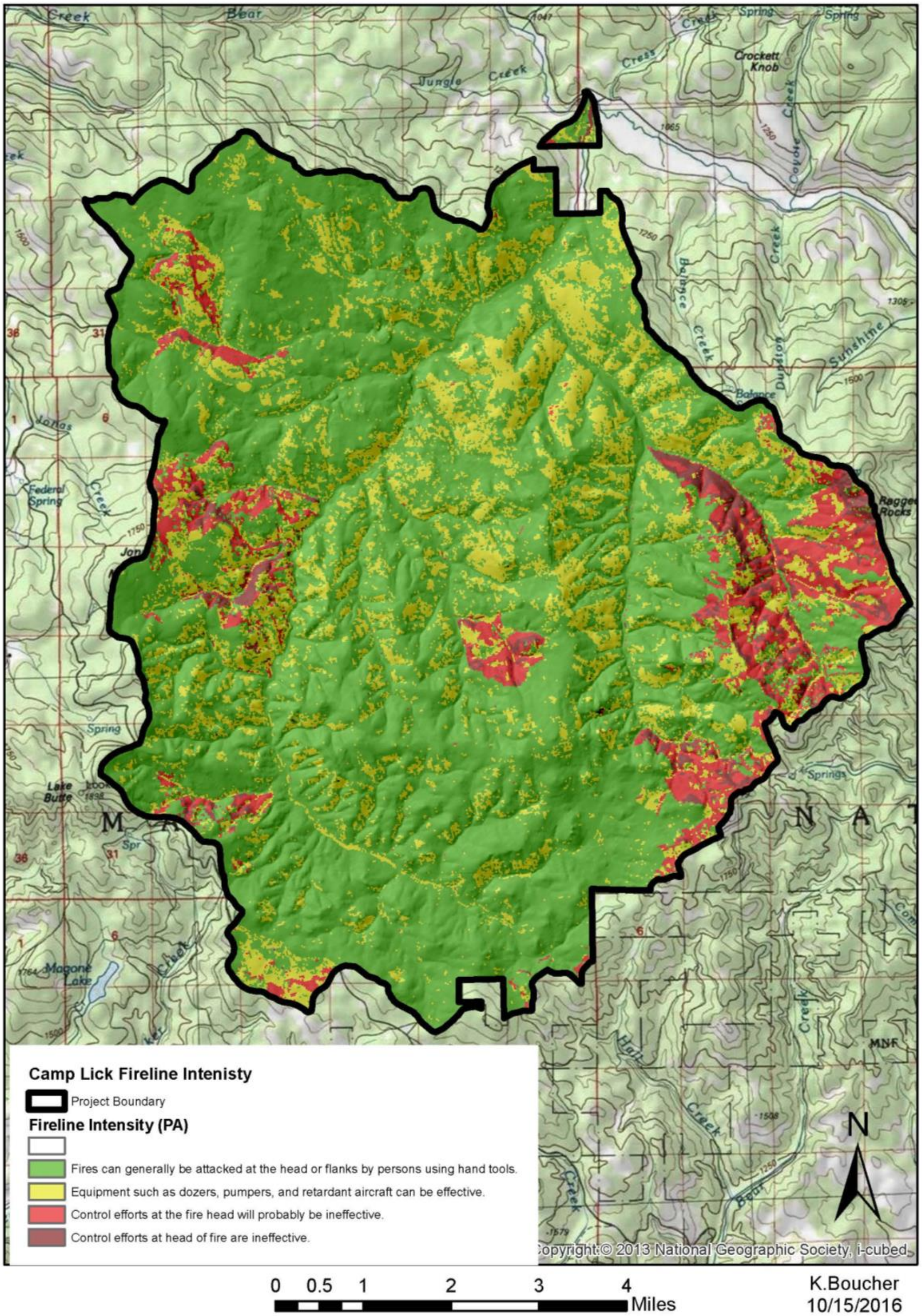

Figure 5. Expected fireline intensity with the proposed action (alternative 2) post-treatment

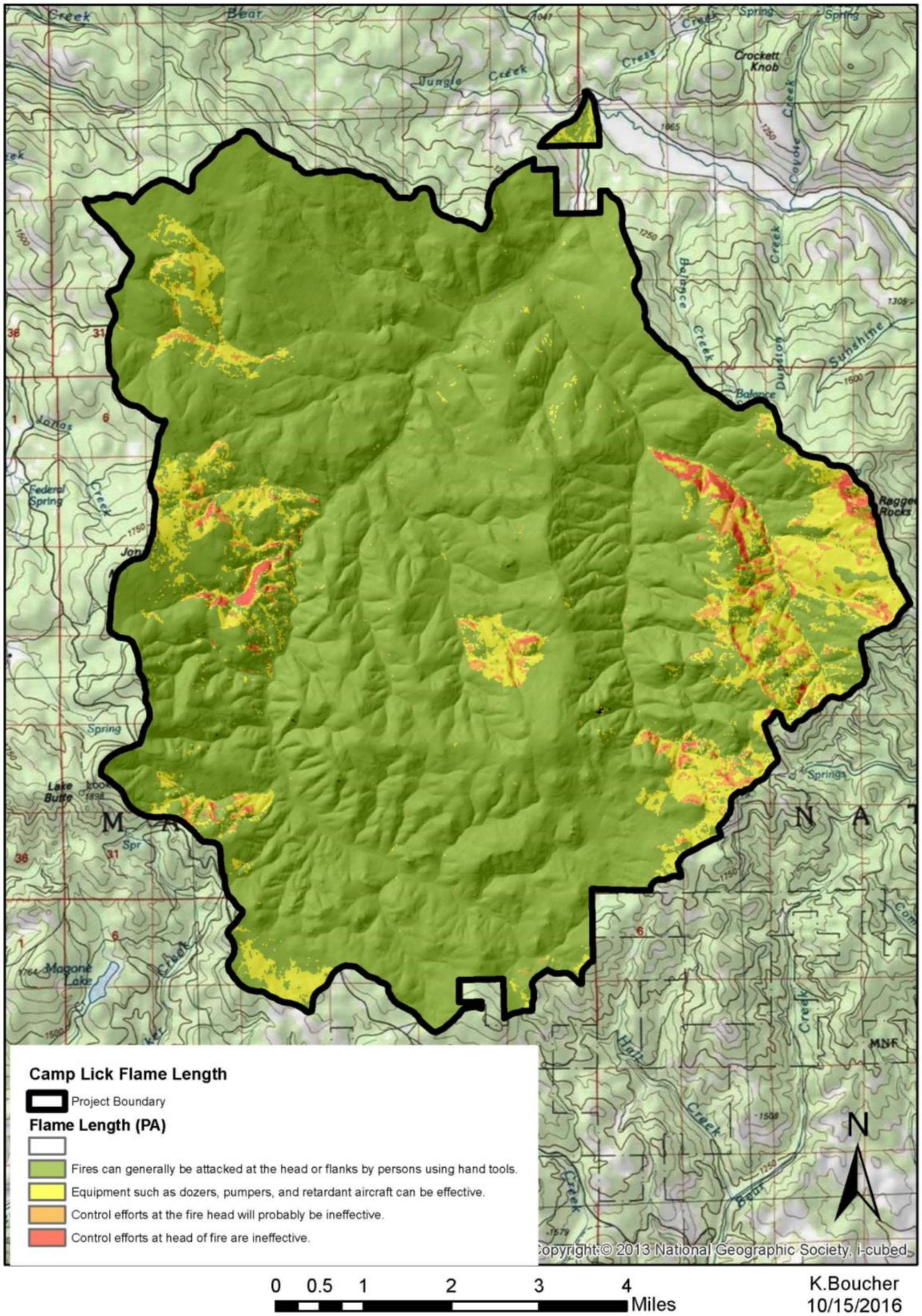

Figure 6. Expected flame length for the proposed action (alternative 2) post-treatment